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WASTE DISCHARGE REQUIREMENTS FOR CALPINE SISKIYOU GEOTHERMAL PARTNERS, L.P., AND CPN TELEPHONE FLAT, INC., AND U.S. DEPARTMENT OF AGRICULTURE, FOREST SERVICE AND U.S. DEPARTMENT OF INTERIOR, BUREAU OF LAND MANAGEMENT GLASS MOUNTAIN UNIT GEOTHERMAL EXPLORATION AND DEVELOPMENT PROJECTS SISKIYOU COUNTY

REGULATORY OVERVIEW

These draft Waste Discharge Requirements (WDRs) regulate the discharge and potential discharge of wastes from a geothermal exploration project in Siskiyou County just east of Mt Shasta. They replace existing WDRs to reflect the current lease ownership and regulate the transfer of geothermal fluid from geothermal fluids sumps to well heads for re-injection, storage of geothermal fluid prior to re-injection, storage of drilling mud and cuttings, storage of hazardous materials used in the drilling operation and the monitoring of surface and groundwater quality. The draft WDRs **do not** regulate the Re-injection of geothermal fluids from the well head to the geothermal aquifer, including but not limited to approval of wells for re-injection, flow rate and volume of geothermal fluids injected, well location, casing design, casing leak detection, additives, leak detection and inspection. These elements of the geothermal exploration project are regulated by the U.S. Department of Interior, Bureau of Land Management (BLM) and the U.S. Environmental Protection Agency (USEPA) under the federal Underground Injection Control (UIC) Program

TECHNICAL BACKGROUND

In order to extract geothermal energy for electrical power generation a geothermal resource must meet certain conditions. The trapped heated water, present in the faults, fractures and pores of the high temperature rock, should ideally be in excess of 300° F and not greater than 10,000 feet below the surface. To locate and evaluate such resources it is necessary to implement an exploration program. For power plant design purposes it is necessary to characterize the enthalpy properties of the hot water/steam mix as it exits at the well head. Enthalpy is a thermodynamic property that can most easily be thought of in the context of geothermal power generation as “energy content.” The purpose of the exploration process is to locate and identify wells that are capable of delivering geothermal fluids of sufficiently high enthalpy to be suitable for the generation of electrical power. If a geothermal electric generating facility is eventually constructed, the geothermal fluids will be transported via surface pipelines from the wells to a dual-flash geothermal power plant if a geothermal electric generating facility is constructed.

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The turbine exhaust steam from the plant will be condensed and pumped to a cooling tower. Spent brine and condensate (geothermal fluid) will be pumped through surface pipelines to injection wells for injection back to the subsurface geothermal reservoir.

A typical Glass Mountain geothermal well has the following specifications:

Overall Depth	13,000 Ft.
Casing Size	9.625 In.
Casing Depth	4000 Ft.
Slotted Liner Size	7 In.
Slotted Liner Depth	9,000 Ft.
Open Hole Size	8.5 In.
Bore Hole Temp.	475° F

The analytical data from geothermal wells in the Medicine Lake highlands suggests that the geothermal fluid may be high in arsenic and may contain small amounts of mercury.

SITE HISTORY

The Medicine Lake Highlands has been a source of interest for possible geothermal development since the mid-1960's. In 1970, the Geothermal Steam Act was adopted and subsequent regulations provided a mechanism for leasing of public lands for exploration, development and utilization of geothermal resources. The U.S. Geological Survey, (USGS), recognized the geothermal development potential in the Medicine Lake Highlands and designated 15,371 acres of this area in 1970 as the Glass Mountain Known Geothermal Resource Area (KGRA).

An Environmental Assessment (EA) for the geothermal exploration leasing in the Glass Mountain KGRA was initially prepared by the U.S. Department of Agriculture, Forest Service (USFS) in 1981 and a Supplemental EA for geothermal development leasing was prepared by the USFS and U.S. Department of Interior, Bureau of Land Management (BLM) in 1984. Geothermal leases in the Glass Mountain KGRA were first issued in the 1980's after competitive lease sales by BLM.

Subsequent to the sale of the KGRA lease, the Central Valley Water Board began issuing WDRs that regulated the discharge or potential discharge of wastes associated with exploration activities to various parties as follows:

- WDR Order No. 83-083 was issued to Union Oil Company in 1983, for general exploration activities.
- WDR Order No. 84-109 was issued in 1984 to replace Order No. 83-083 and named both Union Oil Company and USFS. This Order regulated the discharge of drilling waste to clay-lined sumps (from the drilling of six geothermal wells located in both the Central Valley and North Coast Regions).

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- WDR Order No. 88-095 was issued in 1988 to replace Order No. 84-109 and was issued to Union Oil Company and USFS. Order No. 88-095 did not regulate discharges from the drilling of specific wells and covered the entire geothermal lease area, including both the Central Valley and the North Coast Regions.
- WDR Order No. 91-080 was adopted in 1991 to change the name of the Discharger to Unocal Corporation.
- WDR Order No. 95-199 was adopted in In 1995, to reflect that California Energy General Corporation (CEGC) had acquired the leases from Unocal Corporation. This Order was issued to CEGC and the USFS, and covered activities in the entire Glass Mountain Geothermal Unit Lease Area, including Fourmile Hill, which is within the North Coast Region, and Telephone Flat, which is within the Central Valley Region.
- Calpine Corporation purchased California Energy General Corporation in October 2001, and changed the name of the corporation to CPN Telephone Flat, Inc.
- On 27 June 2002 the North Coast Water Board adopted WDR Order No. R1-2002-0030 naming Calpine Corporation, USFS and BLM as Dischargers, for a discharge of geothermal fluid and associated wastes from geothermal exploration operations by Calpine Corporation in the Fourmile Hill area (an area previously covered under WDR Order No. 95-199). Order No. R1-2002-0030 only regulated a portion of the activities occurring in the North Coast Region, as there were other Calpine activities in the North Coast Region that continued to be regulated by the Central Valley Water Board under Order No. 95-199.
- A Memorandum of Agreement, (MOA), among Calpine Corporation, CPN Telephone Flat, Inc., the North Coast Water Board, and the Central Valley Water Board, was signed and became effective on 30 August 2002. The MOA states that each regional board shall regulate the geothermal “exploration” activities within their respective regions. However, the MOA stated that the Central Valley Water Board shall regulate the entire Glass Mountain Exploratory Project until the North Coast Water Board is able to adopt WDR for the parts of the Glass Mountain Exploratory Project that lie within their region.
- On 26 September 2002 the North Coast Water Board adopted Order No R-1-2002-0089, which revised Order No. R1-2002-0030 to allow Calpine Corporation to transfer geothermal fluids to geothermal wells within the Central Valley Region for re-injection.

PRESENT STATUS OF GEOTHERMAL EXPLORATION & DEVELOPMENT

A Report of Waste Discharge (ROWD) and supplemental information submitted by the Discharger on 23 March 2003 presented a list of proposed new wells and temperature

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gradient holes that may be drilled and/or tested. All of these new wells and temperature gradient holes have been referenced in environmental documents.

In addition to the drilling of new geothermal wells and temperature gradient holes, the Discharger proposes to flow test existing Wells Nos. 68-8, 31-17 and 87-13 in the Telephone Flat area. The Discharger proposes to re-inject these geothermal fluids into existing wells within the project area provided that such activity has been approved by BLM and USEPA.

Wastes produced during drilling operations include soil, drill (rock) cuttings, drilling muds with additives, oil and associated wastewater. At the conclusion of drilling, drilling muds may be mechanically dewatered and discharged to a lined cuttings sump or transported offsite for disposal at a regulated drilling mud disposal facility. Liquid from the dewatering will be discharged to a geothermal fluids sump. Auxiliary tanks will be used to collect any extraneous rig runoff and wash water used for separating solid drill cuttings.

Drill cutting solids from temperature gradient holes will be mechanically separated, and deposited in unlined "temperature gradient hole cutting sumps" (approximately 5,000 to 25,000 gallon capacity) located adjacent to drilling pads. Drill cutting solids from geothermal wells will be mechanically separated, and deposited in a geothermal well cutting sumps (approximately 187,000 gallon capacity) lined with a minimum two-foot thickness of compacted clay with a permeability of less than 1×10^{-6} centimeters per second (cm/sec).

Bore cleanout and flow tests will be performed at the completion of drilling to remove drill cuttings and mud and evaluate the well for geothermal production. The liquid phase geothermal fluid from the test will be discharged to either a new or existing "geothermal fluid sumps" having a liner with a minimum two-foot thickness of compacted clay with a permeability of less than 1×10^{-6} cm/sec. The rate of discharge will be approximately 500-600 gallons per minute. The sumps have a volume of approximately 750,000 gallons and an area of approximately 10,000 square feet.

Re-injection to a geothermal well will take place concurrently with the well test to a well approved for this purpose by BLM and USEPA. At the completion of each well test, any remaining fluids in the discharge sump will be re-injected within 60 days or in no case later than **1 November** in any calendar year. Initially, the lines from the sumps to the re-injection wells will be approximately six inch diameter steel with grooved clamped joints tested at twice the operating pressure.

PROPOSED WASTE DISCHARGE REQUIREMENTS

The latest ROWD requested a revision of WDR Order No. 95-199 to cover additional geothermal exploration work proposed by the Discharger. In addition to the construction of new wells and additional flow testing of existing wells, the Discharger in the ROWD proposed to use acid for formation stimulation in the production zone of exploration well

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Nos. 68-8, 31-17 and 87-13. BLM, in a letter dated 17 April 2006, limited acid formation stimulation to use in well No. 31-17 only, until NEPA and CEQA review have been completed for the well Nos. 68-8 and 87-13. In May 2003, the leases owned by Calpine Corporation were moved to their wholly owned subsidiary, Calpine Siskiyou Geothermal Partners, L.P.

The proposed WDR Order covers the activities listed in the ROWD with respect to aboveground operations and a restriction on the use of acid for formation stimulation to well No. 31-17. Calpine Corporation submitted a letter to the Central Valley Water Board dated 10 January 2006 informing the Board that they intended to begin construction for the Telephone Flat Development Project in 2006, and requesting that tentative WDRs be placed on the Board agenda as soon as possible. Again, the proposed WDRs do not cover subsurface well construction or injection of geothermal fluids.

ENVIRONMENTAL AND REGULATORY ISSUES

In their written comments to staff, environmental groups, Indian tribes and private individuals have expressed numerous environmental concerns which are beyond the Water Boards authority to regulate. These concerns include but are not limited to esthetics, cultural values, noise, air pollution, CEQA issues, a potential conflict of interest created by naming one of the regulators (BLM) as a Discharger, microseismicity and formation stimulation. The concerns regarding microseismicity (a casing design and geothermal well monitoring issue) and formation stimulation may have potential to impact groundwater quality. Microseismicity and formation stimulation will be addressed by BLM and USEPA under the Federal UIC program and are discussed briefly below.

Microseismicity It has been well documented at the Geysers Geothermal Power Operation in Lake and Sonoma Counties and other locations that the extraction of geothermal fluids and injection of make-up water can result in "swarms" of low intensity earthquakes. A microseismic swarm which occurred at the Medicine Lake Highlands in September 1988 was documented in the "Journal of Geology" and may have resulted from the formation stimulation of Well No. 31-17, which took place around that time. The concerned parties believe that these earthquakes may compromise the integrity of the geothermal wells and result in contamination of the shallow aquifer. BLM states that the safeguards employed, including measurement of pressure drop, TV inspection of the casing and groundwater monitoring, will mitigate the concern. They also point out that there have been no problems with casing integrity at the geysers facility where microseismicity is relatively common. A review of the literature has failed to reveal any instances where seismic events have resulted in well casing damage. The Discharger is required to inspect wells and sumps after an event greater than 5.0 on the Richter scale.

Formation Stimulation Formation stimulation is a general term which includes a number of techniques used to increase the production of a well. However in this Order, formation stimulation refers only to the injection of hydrochloric and/or

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hydrofluoric acids into a well's production formation. The quantity of acid used would vary from well to well and could range from 1,000 to 60,000 gallons per well. After allowing the acid sufficient time to dissolve the precipitated minerals in the geothermal reservoir, the spent acid is flowed back to the surface, discharged to the well site geothermal fluids sump, and immediately injected back into the geothermal reservoir. To insure re-injection remains uninterrupted, the Discharger will maintain two re-injection pumps, one primary and one spare, at each geothermal fluid sump being used for formation stimulation. Spare pumps will be tested on a regular basis to insure they remain in operating condition. A spill plan for the materials to be used in the stimulation has been prepared as required by BLM.

Formation stimulation is used routinely in the oil and gas industry and was in fact used previously at geothermal well Nos. 31-17 and 68-8 in Telephone Flat by California Energy General, the previous lessee. BLM is confident that acid injection can be employed in an environmentally safe manner at Medicine Lake. BLM has stated, however, that with the exception of Well No. 31-17, no further formation stimulation may take place until NEPA and CEQA review has been completed. Well No. 31-17 has been excepted because a sundry notice approving the procedure for that well was signed by BLM in 2002.

The concerned parties have stated in their comments that formation stimulation poses a threat to water quality through: 1) potentially compromising the aquatard (capping layer) between the shallow potable aquifer and the deep geothermal aquifer which contains TDS, arsenic, boron and other pollutants; 2) mobilizing metals such as mercury, which may enter groundwater through sump leakage, spills and leakage during transfer to an injection well; and 3) spills of the hazardous substances used in the acidization process, (hydrochloric acid and ammonium fluoride).

Spills and sump leakage do pose threats to water quality, however adherence to the WDR will mitigate these threats. BLM and Central Valley Water Board staff have determined that cross contamination between the shallow and geothermal aquifers is highly unlikely when the magnitude of the separation and the required UIC safeguards are considered.

Formation Stimulation (regulatory concerns) Concerned parties also claim that the procedure as described in this Order is contrary to the regulations because of: 1) failure of the environmental documents to cover these procedures; and 2) failure to involve the California Department of Toxics Substances Control (DTSC), the state agency responsible for the regulation of hazardous waste in California. They note that the North Coast Regional Water Board prohibited formation stimulation in the Fourmile Hill WDR.

A detailed discussion of formation stimulation does not appear in any of the environmental documents for either the Fourmile Hill or Telephone Flat projects, however well "work overs" are specified in the April 1995 Glass Mountain Unit Geothermal Exploration Project EA/IS which applies only to Telephone Flat.

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Well work overs, which can include formation stimulation, are not mentioned in any of the Fourmile Hill documents. (Fourmile Hill is entirely within the North Coast Region)

In 1978, USEPA proposed hazardous waste management standards that included reduced requirements for several types of large volume wastes. Subsequently Congress exempted these wastes from RCRA (Resource Conservation and Recovery Act), Subtitle C hazardous waste regulations. Among the wastes covered by the 1978 proposal were “gas and oil drilling muds and oil production brines.” The oil and gas exemption was expanded in 1980 to include drilling fluids and produced water, from crude oil, natural gas and geothermal wells. The extended list of exempt wastes includes “hydrogen sulfide abatement wastes from geothermal energy production” and “well completion, treatment and stimulation fluids.” In California, DTSC has been granted primary enforcement authority for hazardous waste regulation by USEPA. These wastes, however, are exempt from regulation as hazardous waste by Health & Safety Code, Title 22, section 25143.1, subdivision (a) which provides: “Any geothermal waste resulting from drilling for geothermal resources is exempt from the requirements of this chapter because the disposal of these geothermal wastes is regulated by the California Regional Water Quality Control Boards.” This Order incorporates the regulations as they are presently interpreted. A copy of this Order has been sent to DTSC for comment. To date no comments have been received.

Interested parties have also expressed concern over three areas that are covered in the proposed WDRs, namely, sump design, transfer of geothermal fluids at or above the ground surface and a comprehensive hydrology monitoring plan.

Sump Design The Central Valley Water Board has required that the existing geothermal fluids sumps in Telephone Flat, namely 68-8, 31-17 and 87-13 be re-lined before being used for containment of geothermal fluid. The sumps at 31-17 and 68-8 were re-lined in the fall of 2002 and the liners certified by a registered civil engineer. Nevertheless it has been stated by the environmental groups that the existing geothermal fluids sumps have percolation problems and may not be adequate for containment of geothermal fluids. When the snow cover has melted, and access becomes possible, all three sumps will be inspected. It is noteworthy that even in the Salton Sea area, where the geothermal fluid is extremely salty (250,000 mg/L TDS) and definitely exceeds hazardous criteria for some metals, the Regional Water Board does not require Class 2 Surface Impoundments for well pad test sumps and many of the sumps have only 1 foot thick clay liners.

Transfer of Geothermal Fluids After discharge to the sumps the geothermal fluid will be conveyed to the injection wells by joined sections of aboveground steel pipe. Steel pipe of the type specified in the WDRs is used by the Discharger to make transfers at the Geysers geothermal operation in Lake County. Central Valley Water Board Staff in Sacramento responsible for regulation of the Geysers facility have stated that steel pipe of this design has been used successfully, and is relatively leak free. Our information suggests that this action will be successful in reducing leakage

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to an acceptable level. In addition the Discharger is required to inspect the pipeline **daily** during transfer of geothermal fluid, to maintain a log and to install a leak detection alarm or shut off device.

Comprehensive Hydrology Monitoring Plan The Discharger has been required to submit a comprehensive hydrology monitoring plan (Plan) which includes water quality sampling of several monitoring and production wells, surface water bodies and snow pack. The Plan has been incorporated into the Monitoring and Reporting Program of this Order.

SUMMARY AND RECOMMENDATION

Since the early 1980s a number of private companies have conducted geothermal exploration (drilling of wells and testing of resources) on USFS leases within the Glass Mountain KGRA. Discharge of waste and other water quality related operations have been regulated through WDRs from this office since 1983. By authority of the Geothermal Steam Act, the drilling of wells and “down hole” issues are regulated by BLM and USEPA under the Federal UIC program. Environmental groups, Indian tribes and other interested parties have expressed many water quality related concerns about geothermal exploration and development at Medicine Lake. These concerns may be divided into four basic categories: Formation stimulation, sump design, geothermal fluid transfer and microseismicity. Staff believe that these concerns have been adequately addressed as described in this report. Staff considers the waste discharge requirements to be protective of ground and surface water quality and recommend that the Central Valley Water Board adopt the tentative Order.